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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

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Office Action Summary	Application No.	Applicant(s)	
	10/611,291	PATTERSON, R. HUGO	
	Examiner Brent S. Stace	Art Unit 2161	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) Responsive to communication(s) filed on 21 February 2007.
- 2a) This action is FINAL. 2b) This action is non-final.
- 3) Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) Claim(s) 1,3-11,13-18,20-22,24-33,35-43 and 45-50 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) Claim(s) _____ is/are allowed.
- 6) Claim(s) 1,3-11,13-18,20-22,24-33,35-43 and 45-50 is/are rejected.
- 7) Claim(s) _____ is/are objected to.
- 8) Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) The specification is objected to by the Examiner.
- 10) The drawing(s) filed on 11 May 2006 is/are: a) accepted or b) objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) All b) Some * c) None of:
1. Certified copies of the priority documents have been received.
 2. Certified copies of the priority documents have been received in Application No. _____.
 3. Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) Notice of References Cited (PTO-892)
- 2) Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date 3/19/07.
- 4) Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) Notice of Informal Patent Application
- 6) Other: _____

DETAILED ACTION

Remarks

1. This communication is responsive to the amendment filed February 21st, 2007. Claims 1, 3-11, 13-18, 20-22, 24-33, 35-43, and 45-50 are pending. In the amendment filed February 21st, 2007, Claims 1, 8, 13-15, 20, 27, 30-33, 35-43, and 45-50 are amended, Claims 2, 12, 19, 23, 34, 44, and 51 are canceled, and Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 are independent. The examiner acknowledges that no new matter was introduced and the claims are supported by the specification.
2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on February 21st, 2007 has been entered.

Response to Arguments

3. The Applicant's arguments filed February 21st, 2007 with respect to Claims 1, 3-11, 13-18, 20-22, 24-33, 35-43, and 45-50 have been considered but are not persuasive.
4. The examiner would like to note that "alternative #2" (Zwilling to shrink files before applying Hitz to take snapshots of the shrunk files) in the Applicant's remarks is

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the correct paradigm for considering the Zwilling and Hitz references in combination.

Since alternative #2 is correct and alternatives #1 and #3 are incorrect, only alternative #2 is considered below.

5. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 for the prior art(s) allegedly not teaching "garbage collecting in a storage device," the examiner respectfully disagrees. Zwilling does garbage collection because used parts of a file are moved to unused allocated parts of the file and any unreferenced parts of a file are deallocated. This enables a smaller size for a file and can be seen as removing the garbage (unreferenced and allocated units) from a file. As shown below, mostly in Zwilling, col. 5, lines 29-52, Zwilling locates used/referenced data units, moves/copies them to an unallocated area, then unallocates the units that were used as the source for copying/moving.

6. The applicant's argue that pruned walking of a storage tree is an alleged advantage that makes the prior art non-obvious. However, Zwilling accomplishes what can be construed as prune walking by searching for a part of a file by its key in a tree. This eliminates the need to look at a number of nodes in the tree thus saving time, and the tree structure saves space required for keeping information about the files in Zwilling. This is mostly taught in Zwilling, cols. 8-9, lines 46-17.

7. Applicant's also argue that an advantage of a log is an alleged advantage that makes the prior art non-obvious. However, Zwilling, col. 10, lines 49-56 appears to be teaching what the applicant's are arguing is allegedly novel rendering the invention allegedly non-obvious.

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8. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 using the rationale of "alternative #3," these arguments are invalid since alternative #3 was not used in rejecting these claims. Alternative #2 was used.

9. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 for the prior art(s) allegedly not teaching "garbage collecting within a range of addresses in a storage system," the examiner respectfully disagrees. The files in Zwilling must be stored somewhere. The device on which the files are stored is the storage system. Zwilling gives examples of some devices at the bottom on Col. 3. Zwilling also does garbage collection as shown above because used parts of a file are moved to unused allocated parts of the file and any unreferenced parts of a file are deallocated. This enables a smaller size for a file and can be seen as removing the garbage (unreferenced and allocated units) from a file (Zwilling, col. 5, lines 29-52).

The range of address that this garbage collection covers is the whole file (the address range of the blocks/units comprising the file), since the whole files must be considered for garbage collection to move data within the file. Alternatively, a secondary range of addresses can be construed from the range of blocks/units addresses above the fence in Zwilling since this area of the file is being collected as garbage and deallocated.

10. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 for the prior art(s) allegedly not teaching "whether an allocation unit is unreferenced/inactive or not," the examiner respectfully disagrees. Zwilling must have a determination of a block being used/active/referenced and unused/inactive/unreferenced in order to copy the allocation units and guarantee file

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integrity. This is also shown in Zwilling, col. 12, line 37 "not in use" and Zwilling, col. 5, lines 37 "if an allocation unit...is used."

11. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 for the prior art(s) allegedly not teaching "copying or deleting allocation units based on whether or not they are referenced/active," the examiner respectfully disagrees. This argument has been met above in the discussion above on how Zwilling teaches garbage collection, and appears to be given at least some merit by the applicant's own summary of Zwilling in the Applicant's remarks.

12. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 for the prior art(s) allegedly not teaching "a plurality of storage trees," the examiner respectfully disagrees. Applicant admitted to Zwilling teaching at least a single binary tree (applicant's remarks, p. 35, approx. middle of page). The binary tree in Zwilling has pages containing the data records that form leaf nodes of the tree (Zwilling, col. 8, lines 49-51 as noted from applicant's remarks). At this point in this response we have a binary tree with nodes (so at least 2 nodes total in a tree). A tree with one node (root node) is still a tree in a tree structure. This is the most basic form of a tree. Any nodes descending from the root node can be considered as sub-trees within the main tree. Therefore, the nodes of the binary tree in Zwilling, make trees since all the nodes of a tree can be considered trees by themselves. They are considered storage trees since they store information about and of the files. Depending on what subtrees within the main tree can be considered as trees by alone (there are at least as many trees as there are nodes), you are left with trees containing a plurality of

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nodes (especially considering Zwilling is implying the use of many nodes in the tree since there are many allocation units (Zwilling, col. 12, lines 24-53)). Alternatively, Zwilling has this tree for each file, and since Zwilling is doing operation on many files, this makes many trees.

13. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 for the prior art(s) allegedly not teaching "having multiple references to the same block," the examiner respectfully disagrees. As shown above, Zwilling has multiple trees, and the trees doubly-linked nature makes references to the same block of data. The Applicants contend that the claim calls for "references between storage trees" however this is not claimed subject matter and can still be seen as being taught in Zwilling as the multiple storage trees were taught above with their doubly-linked nature here (seen in Zwilling, col. 8, lines 55-60).

14. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 for the prior art(s) allegedly not teaching "pruning walking of the plurality of storage trees to determine active blocks of data within said range," the examiner respectfully disagrees. Zwilling accomplishes what can be construed as prune walking by searching for a part of a file by its key in a tree. This eliminates the need to look at a number of nodes in the tree thus saving time. This is mostly taught in Zwilling, cols. 8-9, lines 46-17.

15. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 for the prior art(s) allegedly not teaching "which blocks of data to delete," this does not appear to be claimed subject matter.

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16. As to the applicant's arguments with respect to Claims 1, 8, 15, 20, 27, 31, 33, 40, and 47 for the prior art(s) allegedly not teaching "skipping walking of the plurality of descendent nodes based on said determining," the examiner respectfully disagrees. Zwilling skips a number of nodes by searching for a part of a file by its key in a tree. This eliminates the need to look at a number of nodes in the tree thus saving time. This is mostly taught in Zwilling, cols. 8-9, lines 46-17.

17. The other claims argued merely because of a dependency on a previously argued claim(s) in the arguments presented to the examiner, filed February 21st, 2007, are moot in view of the examiner's interpretation of the claims and art and are still considered rejected based on their respective rejections from the first Office action (parts of recited again below).

Response to Amendment

Specification

18. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Objections

19. In light of the applicant's respective arguments or respective amendments, some previous claim objections to the claims have been withdrawn.

20. Claims 27-30 33, and 35-39 are objected to because of the following informalities:

- a. Claim 33 recites poor sentence structure in line 9 where it recites "a plurality nodes." This objection propagates downward through the dependant Claims 35-39.
- b. Claim 27 recites poor sentence structure in line 11 where it recites "logic to prune walking of nodes." This objection propagates downward through the dependant Claims 28-30. In the English language, infinitive forms of verbs do not end in "ing." As such, it appears that the claim should read as "to prune walk." However, such an amendment would not make the remainder of the phrase fall in line with good sentence structure, therefore, further appropriate correction is needed. A possible amendment may read as "logic to prune walk[ing]-of nodes"

Appropriate correction is required.

Claim Rejections - 35 USC § 112

21. In light of the applicant's respective arguments or respective amendments, the previous 35 USC § 112 rejections to the claims have been withdrawn.

Claim Rejections - 35 USC § 101

22. In light of the applicant's respective arguments or respective amendments, some previous 35 USC § 101 rejections to the claims have been withdrawn.

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23. 35 U.S.C. 101 reads as follows:

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

24. Claims 31, 32, 33, 35-39, 40-43, 45, 46, and 47-50 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.

25. Claims 31 and 32 are claims that do not meet the useful, concrete tangible result required for 35 U.S.C. 101. Specifically, Claim 31 appears to be no more than a program per se. This rejection is not remedied in any dependent claim; therefore, Claim 32 is rejected for the same reason. Applicant's arguments point to paragraph [0034] in the applicant's specification that teaches that the invention can be implemented by hardware, software, or a combination of the two. Seeing that the claims do not recite any definitive hardware elements, it appears that the claims are merely software. Adding hardware elements into the claim (e.g. processor) or amending the software to be stored on an appropriate computer medium are recommended actions that the applicant's can pursue.

26. To expedite a complete examination of the instant application, the Claims rejected under 35 U.S.C. 101 above are further rejected as set forth below in anticipation of applicant amending these Claims to place them within the four statutory categories of invention.

Claim Rejections - 35 USC § 103

27. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

28. Claims 1, 3-7, 18, 20-22, 24-33, 35-39, and 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,249,792 (Zwilling et al.) in view of U.S. Patent No. 5,963,962 (Hitz et al.).

For Claim 1, Zwilling teaches: "A method of garbage collecting in a storage device [Zwilling, col. 5, lines 29-52 with Zwilling, Fig. 2] comprising:

- locating blocks of data in a log that are referenced and within a range at a tail of the log using pruned walking, the range representing an address range within an allocated segment of the log, [Zwilling, col. 12, lines 24-53 with Zwilling, Fig. 2 with Zwilling, col. 8, lines 60-64 with Zwilling, Figs. 3C and 3E]
- wherein the log is implemented in a hierarchical architecture [Zwilling, cols. 8-9, lines 46-26 with Zwilling, col. 12, lines 31-34]
- ...copying the blocks of data that are referenced...and within the range to an unallocated segment of the log [Zwilling, col. 5, lines 34-52 with Zwilling, col. 12, lines 41-53]
- ...marking the range at the tail of the log as unallocated so that at least a portion of an address space within the range can be reclaimed" [Zwilling, col. 5, lines 34-52 with Zwilling, col. 12, lines 31-34].

Zwilling discloses the above limitations but does not expressly teach:

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- "...having a plurality of storage trees, each storage tree representing a snapshot taken at a point in time of target data being processed, each storage tree having a plurality of nodes and each node representing a block of data of a snapshot associated with each storage tree;
- ...by one or more other blocks of data of other nodes...wherein blocks of data that are not referenced by other blocks of data and within the range remain untouched."

With respect to Claim 1, an analogous art, Hitz, teaches:

- "...having a plurality of storage trees, [Hitz, cols. 17-18, lines 66-16] each representing a snapshot taken at a point in time of target data being processed, [Hitz, col. 17, lines 40-49] each storage tree having a plurality nodes [Hitz, cols. 17-18, lines 66-16] and each node representing a segment of data of a snapshot associated with each storage tree; [Hitz, col. 17, lines 40-49 with Hitz, cols. 17-18, lines 66-16]
- ...by one or more other blocks of data of other nodes [Hitz, col. 18, lines 35-38] ...wherein blocks of data that are not referenced by other blocks of data and within the range remain untouched" [Hitz, col. 15, lines 55-57 with Hitz, col. 16, lines 15-17 with Hitz, col. 20, lines 25-35 with Zwilling, col. 5, lines 29-52 with Zwilling, col. 6, lines 42-49 with Zwilling, col. 12, lines 36-37].

It would have been obvious to one of ordinary skill in the art at the time of invention having the teachings of Hitz and Zwilling before him/her to combine Hitz with

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Zwilling because both inventions are directed towards conserving file space (Zwilling shrinks and Hitz only snapshots data that was changed at a block level (not a file level)).

Hitz's invention would have been expected to successfully work well with Zwilling's invention because both inventions use file systems on computers. Zwilling discloses an on-line dynamic file shrink facility comprising shrinking log files. However, Zwilling does not expressly disclose storage trees each representing a snapshot and where unreferenced data remains untouched. Hitz discloses a write anywhere file-system layout comprising storage trees (file system snapshot trees) each representing a snapshot and where unreferenced data remains untouched.

It would have been obvious to one of ordinary skill in the art at the time of invention having the teachings of Hitz and Zwilling before him/her to take the write anywhere file-system layout from Hitz and install it into the invention of Zwilling, thereby offering the obvious advantage of taking snapshots of garbage collected/shrunken data, thus saving space. Shrinking the files prior to snapshotting them frees more space in Hitz thus creating more room in Hitz so that another later snapshot won't be prematurely forced out when space in Hitz runs out (by snapshots consuming unacceptable numbers of disk blocks). Also, shrinking prior to snapshotting guarantees that Hitz will not back up empty blocks (since they are dirtied by becoming empty in a snapshot). This also conserves space in Hitz. In fact, Hitz desires files to be in a shrunken form (Hitz, col. 5, lines 37-40). Therefore, Hitz is merely using Zwilling's shrinking technique to obtain files that have no fragments.

Different embodiments of Zwilling are used in the rejection for Claim 1 and its respective dependent claims. Zwilling (as modified by Hitz) teaches all of Claim 1 with assistance from Zwilling's different embodiments.

Claim 3 can be mapped to Zwilling (as modified by Hitz) as follows: "The method of claim 1, wherein locating the blocks of data that are referenced and within the range includes determining a minimum value among addresses of descendent nodes of a node, [Zwilling, cols. 8-9, lines 46-14] wherein the minimum value represents a minimum address offset of a node that is closest referenced from the blocks of data" [Zwilling, cols. 8-9, lines 46-14 with Zwilling, col. 5, lines 29-52 with Zwilling Fig. 2].

Claim 4 can be mapped to Zwilling (as modified by Hitz) as follows: "The method of claim 3, wherein a location table includes an entry for nodes that reference other nodes [Zwilling, col. 8, lines 46-64 with Zwilling, col. 10, lines 5-13] and wherein determining the minimum value among addresses of descendent nodes of the node includes retrieving the minimum value from an entry in the location table associated with the node" [Zwilling, cols. 8-9, lines 46-14 with Zwilling, col. 10, lines 5-13].

Claim 5 can be mapped to Zwilling (as modified by Hitz) as follows: "The method of claim 4, wherein locating the blocks of data that are referenced and within the range includes processing the descendent nodes of the node upon determining that the minimum value among the addresses of the descent nodes is within the range" [Zwilling, col. 5, lines 29-52].

Claim 6 can be mapped to Zwilling (as modified by Hitz) as follows: "The method of claim 5 comprising modifying the addresses of the copied blocks of data that are

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stored in the location table based on the new locations of the copied blocks of data in the log" [Zwilling, Fig. 3C with Zwilling, col. 8, lines 29-33 with Zwilling, col. 9, lines 4-7].

Claim 7 can be mapped to Zwilling (as modified by Hitz) as follows: "The method of claim 5 further comprising modifying the minimum value in the entry in the table associated with the node when the minimum value changes based on the new locations of the copied blocks of data that are associated with descendent nodes of the node" [Zwilling, Fig. 3C with Zwilling, col. 8, lines 29-33 with Zwilling, col. 9, lines 4-7 with Zwilling, col. 5, lines 29-52 with Zwilling, col. 10, lines 5-13].

For **Claim 18**, Zwilling teaches: "The method of claim 15."

Zwilling discloses the above limitation but does not expressly teach: "...wherein at least one block of data stored in the log is referenced by more than one of other blocks of data."

With respect to Claim 18, an analogous art, Hitz, teaches: "...wherein at least one block of data stored in the log is referenced by more than one of other blocks of data" [Hitz, col. 18, lines 24-30 with Hitz, col. 2, lines 25-36].

It would have been obvious to one of ordinary skill in the art at the time of invention to combine Hitz with Zwilling because both inventions are directed towards storing files on file systems.

Hitz's invention would have been expected to successfully work well with Zwilling's invention because both inventions use file systems on computers. Zwilling discloses an on-line dynamic file shrink facility comprising trees/tables for file information/representation, however Zwilling does not expressly disclose the possibility

that the blocks of data could be repeating by what is known in the art as aliases, shortcuts, or symbolic links. Hitz discloses a write anywhere file-system layout comprising file block indirection.

It would have been obvious to one of ordinary skill in the art at the time of invention to take the file block indirection from Hitz and install it into the method of Zwilling, thereby offering the obvious advantage of extending Zwilling's invention to work on files that contain the same data in attempts to save space as the snapshot size increases thereby increasing the number of active snapshots in Hitz.

For Claim 20, Zwilling teaches: "A system comprising:

- a storage device to store a number of blocks of data, [Zwilling, col. 5, lines 6-12] wherein the blocks of data that are marked as allocated are non-modifiable, [Zwilling, col. 6, lines 5-10] the blocks of data to be stored as a log; [Zwilling, col. 12, lines 15-17] and
- a garbage collection logic to locate the blocks of data that are referenced and within a range at a tail of the log using pruned walking, the range representing and address range within an allocated segment of the log, [Zwilling, col. 12, lines 24-53 with Zwilling, Fig. 2 with Zwilling, col. 8, lines 60-64 with Zwilling, Figs. 3C and 3E]
- wherein the log is implemented in a hierarchical architecture [Zwilling, cols. 8-9, lines 46-26 with Zwilling, col. 12, lines 31-34]
- wherein said garbage collection logic is operable to copy the blocks of data that are referenced and within the range at the fail of the log to a head of the log and

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mark the range as unallocated so that at least a portion of the address space within the range can be reclaimed" [Zwilling, col. 5, lines 29-52 with Zwilling, Fig. 2].

Zwilling discloses the above limitations but does not expressly teach:

- "...having a plurality of storage trees, each representing a snapshot taken at a point in time of target data being processed, each storage tree having a plurality nodes and each node representing a block of data of a snapshot associated with each storage tree."

With respect to Claim 20, an analogous art, Hitz, teaches:

- "...having a plurality of storage trees, [Hitz, cols. 17-18, lines 66-16] each representing a snapshot taken at a point in time of target data being processed, [Hitz, col. 17, lines 40-49] each storage tree having a plurality nodes [Hitz, cols. 17-18, lines 66-16] and each node representing a block of data of a snapshot associated with each storage tree" [Hitz, col. 17, lines 40-49 with Hitz, cols. 17-18, lines 66-16].

It would have been obvious to one of ordinary skill in the art at the time of invention having the teachings of Hitz and Zwilling before him/her to combine Hitz with Zwilling because both inventions are directed towards conserving file space (Zwilling shrinks and Hitz only snapshots data that was changed at a block level (not a file level)).

Hitz's invention would have been expected to successfully work well with Zwilling's invention because both inventions use file systems on computers. Zwilling discloses an on-line dynamic file shrink facility comprising shrinking log files. However,

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Zwilling does not expressly disclose storage trees each representing a snapshot. Hitz discloses a write anywhere file-system layout comprising storage trees (file system snapshot trees) each representing a snapshot.

It would have been obvious to one of ordinary skill in the art at the time of invention having the teachings of Hitz and Zwilling before him/her to take the write anywhere file-system layout from Hitz and install it into the invention of Zwilling, thereby offering the obvious advantage of taking snapshots of garbage collected/shrunken data, thus saving space. Shrinking the files prior to snapshotting them frees more space in Hitz thus creating more room in Hitz so that another later snapshot won't be prematurely forced out when space in Hitz runs out (by snapshots consuming unacceptable numbers of disk blocks). Also, shrinking prior to snapshotting guarantees that Hitz will not back up empty blocks (since they are dirtied by becoming empty in a snapshot). This also conserves space in Hitz. In fact, Hitz desires files to be in a shrunken form (Hitz, col. 5, lines 37-40). Therefore, Hitz is merely using Zwilling's shrinking technique to obtain files that have no fragments.

Different embodiments of Zwilling are used in the rejection for Claim 20 and its respective dependant claims. Zwilling (as modified by Hitz) teaches all of Claim 20 with assistance from Zwilling's different embodiments.

Claim 21 can be mapped to Zwilling (as modified by Hitz) as follows: "The system of claim 20, wherein the garbage collection logic is to copy the blocks of data that are referenced to an unallocated address space of the log" [Zwilling, col. 5, lines 29-52 with Zwilling, Fig. 2].

Claim 22 can be mapped to Zwilling (as modified by Hitz) as follows: "The system of claim 21, wherein the garbage collection logic is to copy the blocks of data that are referenced to a head of the log" [Zwilling, col. 5, lines 29-52 with Zwilling, Fig. 2].

Claim 24 can be mapped to Zwilling (as modified by Hitz) as follows: "The system of claim 20 wherein at least one of the number of blocks of data are referenced by more than one reference" [Hitz, col. 18, lines 24-30 with Hitz, col. 2, lines 25-36 with Hitz, col. 20, lines 25-35].

Claim 25 can be mapped to Zwilling (as modified by Hitz) as follows: "The system of claim 20 comprising a location table to include entries associated with interior nodes of a storage tree, [Zwilling, col. 10, lines 5-13] wherein each entry is to include a minimum value among the addresses of descendent nodes of the associated interior node" [Zwilling, cols. 8-9, lines 46-15 with Zwilling, col. 9, lines 43-51 with Zwilling col. 8, lines 20-35 with Zwilling, col. 7, lines 38-21].

Claim 26 can be mapped to Zwilling (as modified by Hitz) (as modified by) as follows: "The system of claim 25, wherein the garbage collection logic is to locate the blocks of data that are referenced and within the range at the tail of the log based on the minimum values stored in the entries of the location table" [Zwilling, col. 5, lines 29-40 with Zwilling, col. 8, lines 46-65 with Zwilling, col. 10, lines 5-13].

For **Claim 27**, Zwilling teaches:

- "...each leaf node of said plurality of storage trees to include a block of data from said file system [Zwilling, col. 10, lines 5-13 with Zwilling, col. 8, lines 46-65]

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- a storage space to store said blocks of data having been allocated in said set of one or more storage devices; [Zwilling, col. 5, lines 29-52 with Zwilling, Fig. 2]
- having stored therein a minimum address value of descendent nodes of interior nodes of said plurality of storage trees; [Zwilling, cols. 8-9, lines 46-15 with Zwilling, col. 9, lines 43-51 with Zwilling col. 8, lines 20-35 with Zwilling, col. 7, lines 38-21] and
- a garbage collection logic to clean a currently selected range from the tail of said log, [Zwilling, col. 5, lines 29-52 with Zwilling, Fig. 2] said garbage collection logic to prune walking of nodes of said plurality of storage trees based on said set of location tables and said currently selected range" [Zwilling, cols. 8-9, lines 46-17 with Zwilling, col. 5, lines 29-52 with Zwilling, col. 12, lines 24-40].

Zwilling discloses the above limitations but does not expressly teach: "A backup system comprising:

- a plurality of storage trees, each representing a snapshot of a file system at a different time, each storage tree having a plurality of leaf nodes, ...that has been backed up from a set of one or more storage devices
- from a backup storage space
- a set of one or more location tables."

With respect to Claim 27, an analogous art, Hitz, teaches: "A backup system [Hitz, col. 17, lines 40-50] comprising:

- a plurality of storage trees, each representing a snapshot of a file system at a different time, each storage tree having a plurality of leaf nodes, [Hitz, cols. 17-

18, lines 50-14 with Zwilling, col. 10, lines 49-56]...that has been backed up from a set of one or more storage devices [Hitz, cols. 17-18, lines 65-14]

- from a backup storage space [Hitz, cols. 17-18, lines 65-14]
- a set of one or more location tables" [Hitz, cols. 17-18, lines 65-14 with Zwilling, col. 10, lines 5-13].

It would have been obvious to one of ordinary skill in the art at the time of invention having the teachings of Hitz and Zwilling before him/her to combine Hitz with Zwilling because both inventions are directed towards conserving file space (Zwilling shrinks and Hitz only snapshots data that was changed at a block level (not a file level)).

Hitz's invention would have been expected to successfully work well with Zwilling's invention because both inventions use file systems on computers. Zwilling discloses an on-line dynamic file shrink facility comprising a storage tree, location table, and garbage collection, however Zwilling does not expressly disclose storage trees, or tables as relating to snapshots of storage device(s). Hitz discloses a write anywhere file-system layout comprising storage trees from snapshots of a file system.

It would have been obvious to one of ordinary skill in the art at the time of invention to take the storage device (making 2 storage devices), the storage trees of snapshots, and tables from Hitz and install it into the system of Zwilling, thereby offering the obvious advantage of extending Zwilling's invention to work on archived (snapshot) files in attempts to save space as the snapshot size increases thereby increasing the potential number of active snapshots in Hitz. Shrinking the files prior to snapshotting them frees more space in Hitz thus creating more room in Hitz so that another later

snapshot won't be prematurely forced out when space in Hitz runs out (by snapshots consuming unacceptable numbers of disk blocks). Also, shrinking prior to snapshotting guarantees that Hitz will not back up empty blocks (since they are dirtied by becoming empty in a snapshot). This also conserves space in Hitz. In fact, Hitz desires files to be in a shrunken form (Hitz, col. 5, lines 37-40). Therefore, Hitz can be seen as merely using Zwilling's shrinking technique to obtain files that have no fragments.

Different embodiments of Zwilling are used in the rejection for Claim 27 and its respective dependant claims. Zwilling (as modified by Hitz) teaches all of Claim 27 with assistance from Zwilling's different embodiments.

Claim 28 can be mapped to Zwilling (as modified by Hitz) as follows: "The backup system of claim 27, wherein two different nodes of a same storage tree reference a same node in the same storage tree" [Hitz, col. 18, lines 24-30 with Hitz, col. 2, lines 25-36].

Claim 29 can be mapped to Zwilling (as modified by Hitz) as follows: "The backup system of claim 27, wherein the garbage collection logic is to update references to a node that is within the currently selected range based on an update to an entry in the set of one or more location tables" [Zwilling, Fig. 3C with Zwilling, col. 8, lines 29-33 with Zwilling, col. 9, lines 4-7].

Claim 30 can be mapped to Zwilling (as modified by Hitz) as follows: "The backup system of claim 27, wherein the garbage collection logic is to prune walking of the nodes of said plurality of storage trees based on the minimum addresses stored in

the set of one ore more location tables" [Zwilling, cols. 8-9, lines 46-17 with Zwilling, col. 5, lines 29-52 with Zwilling, col. 12, lines 24-40 with Zwilling, col. 10, lines 5-13].

For Claim 31, Zwilling teaches: "An apparatus [Zwilling, cols. 4-5, lines 62-12] comprising:

- ...by recording references to blocks of backed up data [Zwilling, cols. 8-9, lines 46-17 with Zwilling, col. 10, lines 5-13]
- ...an allocator logic to allocate contiguous blocks of storage space from a log of a backup storage space to store said blocks of backed up data [Zwilling, col. 5, lines 29-52 with Zwilling, col. 12, lines 24-40]
- a garbage collection logic...to clean a currently selected contiguous range from the tail of said log, [Zwilling, col. 5, lines 29-52, with Zwilling, Fig. 2] said garbage collection logic to,
 - walk only those nodes of said plurality of storage trees that possibly identify those of said blocks of data that are stored in said currently selected contiguous range or that possibly are themselves stored in said currently selected contiguous range, [Zwilling, cols. 8-9, lines 46-14 with Zwilling, col. 9, lines 43-50] and
 - sweep said currently selected contiguous range, [Zwilling, col. 5, lines 29-52, with Zwilling, Fig. 2] copying blocks of data that are referenced and within the range out of the range and marking the range as unallocated so that at least a portion of the address space within the range can be reclaimed" [Zwilling, col. 5, lines 29-52 with Zwilling, Fig. 2].

Zwilling discloses the above limitations but does not expressly teach:

- "...a backup system to backup a file system, said backup file system including:
 - a tracking logic to generate a plurality of storage trees each storage tree having a plurality of nodes and representing backup snapshots of said file system at different times stored in a set of one or more storage devices
 - ...responsive to deletion of one or more of said backup snapshots."

With respect to Claim 31, an analogous art, Hitz, teaches:

- "...a backup system [Hitz, col. 17, lines 40-50] to backup a file system, [Hitz, cols. 17-18, lines 65-14] said backup file system including:
 - a tracking logic to generate a plurality of storage trees each storage tree having a plurality of nodes and representing backup snapshots of said file system at different times [Hitz, cols. 17-18, lines 65-14] stored in a set of one or more storage devices [Hitz, cols. 17-18, lines 65-14]
 - ...responsive to deletion of one or more of said backup snapshots" [Hitz, cols. 17-18, lines 65-14].

It would have been obvious to one of ordinary skill in the art at the time of invention having the teachings of Hitz and Zwilling before him/her to combine Hitz with Zwilling because both inventions are directed towards conserving file space (Zwilling shrinks and Hitz only snapshots data that was changed at a block level (not a file level)).

Hitz's invention would have been expected to successfully work well with Zwilling's invention because both inventions use file systems on computers. Zwilling discloses an on-line dynamic file shrink facility comprising shrinking log files. However,

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Zwilling does not expressly disclose storage trees each representing a snapshot. Hitz discloses a write anywhere file-system layout comprising storage trees (file system snapshot trees) each representing a snapshot.

It would have been obvious to one of ordinary skill in the art at the time of invention having the teachings of Hitz and Zwilling before him/her to take the write anywhere file-system layout from Hitz and install it into the invention of Zwilling, thereby offering the obvious advantage of taking snapshots of garbage collected/shrunken data, thus saving space. Shrinking the files prior to snapshotting them frees more space in Hitz thus creating more room in Hitz so that another later snapshot won't be prematurely forced out when space in Hitz runs out (by snapshots consuming unacceptable numbers of disk blocks). Also, shrinking prior to snapshotting guarantees that Hitz will not back up empty blocks (since they are dirtied by becoming empty in a snapshot). This also conserves space in Hitz. In fact, Hitz desires files to be in a shrunken form (Hitz, col. 5, lines 37-40). Therefore, Hitz is merely using Zwilling's shrinking technique to obtain files that have no fragments.

Different embodiments of Zwilling are used in the rejection for Claim 31 and its respective dependant claims. Zwilling (as modified by Hitz) teaches all of Claim 31 with assistance from Zwilling's different embodiments.

Claim 32 can be mapped to Zwilling (as modified by Hitz) as follows: "The apparatus of claim 31, wherein the plurality of storage trees include interior nodes and leaf nodes, [Zwilling, col. 8, lines 10-20 with Zwilling, cols. 8-9, lines 46-14] the interior nodes to include references to other nodes in one or more of the plurality of storage

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trees, [Zwilling, cols. 8-9, lines 46-14] two different interior nodes of a same tree references a same node in the same tree" [Hitz, col. 18, lines 24-30 with Hitz, col. 2, lines 25-36].

Claims 33 and 35-39 encompass substantially the same scope of the invention as that of Claims 1, 3-7, respectfully, in addition to a machine-readable medium and some instructions for performing the method steps of Claims 1, 3-7, respectfully. Therefore, Claims 33, 35-39 are rejected for the same reasons as stated above with respect to Claims 1, 3-7, respectfully.

Claim 50 encompasses substantially the same scope of the invention as that of Claim 18, in addition to a machine-readable medium and some instructions for performing the method steps of Claim 18. Therefore, Claim 50 is rejected for the same reasons as stated above with respect to Claim 18.

29. Claims 8-11, 13-17, 40-43, and 45-49 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,249,792 (Zwilling et al.).

For **Claim 8**, Zwilling teaches: "A method comprising:

- garbage collecting within a range of addresses in a storage system [Zwilling, col. 12, lines 24-53 with Zwilling, Fig. 2] having"

With respect to Claim 8, Zwilling teaches in a different embodiment:

- "a plurality of storage trees, each storage tree having a plurality of nodes and having multiple references to the same block of data, the garbage collecting including: [Zwilling, cols. 8-9, lines 46-17]

- pruning walking of the plurality of storage trees to determine active blocks of data within said range, where active blocks of data are those still in one of the plurality of storage trees, [Zwilling, cols. 8-9, lines 46-17 with Zwilling, col. 5, lines 29-52 with Zwilling, col. 12, lines 24-40] the pruning walking including:
 - determining, based on accessing in one of said plurality of storage trees a parent node that has a plurality of descendent nodes, that none of the plurality of descendant nodes are associated with blocks of data within the range; [Zwilling, col. 5, lines 29-52 with Zwilling, col. 12, lines 24-53 with Zwilling, col. 9, lines 56-65] and
 - skipping the walking of the plurality of descendent nodes based on said determining, [Zwilling col. 5, lines 12-16]
- wherein the active blocks determined to be in the range are copied out of the range and the range is marked as unallocated so that at least a portion of the address space within the range can be reclaimed" [Zwilling col. 5, lines 29-52 with Zwilling, Fig. 2].

It would have been obvious to one of ordinary skill in the art at the time of invention to combine the different embodiments of Zwilling because the invention is directed towards shrinking files.

Zwilling discloses an on-line dynamic file shrink facility comprising shrinking log files, however Zwilling does not expressly disclose in that same embodiment how it the shrinking is accomplished (for instance what type of file a log file is considered as being in Zwilling).

It would have been obvious to one of ordinary skill in the art at the time of invention to take the copying of blocks and file shrinking process from Zwilling and install it into the shrinking log files of Zwilling, thereby offering the obvious advantage of shrinking log files to save space.

Even though Zwilling is only one reference being used to reject Claim 8, the rejection on Claim 8 is under 35 U.S.C. 103(a) because different embodiments of Zwilling are used in the rejection for Claim 8 and its respective dependent claims. Zwilling teaches all of Claim 8 through Zwilling's different embodiments.

Claim 9 can be mapped to Zwilling as follows: "The method of claim 8, wherein the blocks of data are stored in a log and the range is a segment of the log" [Zwilling, col. 12, lines 15-53 with Zwilling, Fig. 2].

Claim 10 can be mapped to Zwilling as follows: "The method of claim 9, wherein the segment is at the tail of the log" [Zwilling col. 5, lines 34-52].

Claim 11 can be mapped to Zwilling as follows: "The method of claim 10, wherein the determining is performed by comparing a minimum offset of the plurality of descendent nodes against the range, [Zwilling, cols. 8-9, lines 46-15 with Zwilling, col. 9, lines 43-51 with Zwilling col. 8, lines 20-35] wherein the minimum offset is accessed when walking the parent node and without walking the plurality of descendent nodes" [Zwilling, cols. 8-9, lines 46-15 with Zwilling, col. 9, lines 43-51 with Zwilling col. 8, lines 20-35 with Zwilling, col. 7, lines 38-21].

Claim 13 can be mapped to Zwilling as follows: "The method of claim 8, wherein the range is a segment at the tail of a log and said copying is from the said segment at

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the tail to a segment at the head of the log" [Zwilling col. 5, lines 34-52 with Zwilling, Fig. 2].

Claim 14 can be mapped to Zwilling as follows: "The method of claim 8, wherein said copying includes updating addresses of the copied blocks of data within a location table" [Zwilling, Fig. 3C with Zwilling, col. 8, lines 29-33 with Zwilling, col. 9, lines 4-7].

For **Claim 15**, Zwilling teaches: "A method of garbage collecting in a storage system [Zwilling, col. 5, lines 29-52 with Zwilling, Fig. 2] comprising."

With respect to Claim 15, Zwilling teaches in a different embodiment:

- "...performing following operations until each block of data that is active in a range to be cleaned at a tail of a log of data is copied to a head of the log, [Zwilling col. 5, lines 34-52 with Zwilling, Fig. 2 with Zwilling, col. 12, lines 15-17] wherein the range to be cleaned is a range of addresses in a storage system having a plurality of storage trees each storage tree having a plurality of nodes, wherein a block of data is associated with a node of a storage tree, [Zwilling, col. 10, lines 5-13 with Zwilling col. 8, lines 46-65] the operations including:
 - copying blocks of data associated with child nodes of a current node that are within the range to be cleaned to the head of the log; [Zwilling col. 5, lines 34-52 with Zwilling, Fig. 2]
 - retrieving a block of data associated with the current node, upon determining that a minimum address value among addresses of descendent nodes is within the range to be cleaned; [Zwilling col. 5, lines 29-52 with Zwilling, Fig. 2]

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- designating, as the current node, one of the child nodes of the current node that is an interior node, upon determining that at least one child node is an interior node; [Zwilling, col. 8, lines 46-65] and
- designating, as the current node, an ancestor node of the current node whose descendent nodes are unprocessed; [Zwilling, col. 8, lines 46-65] and
- marking the range as unallocated when the blocks of data that are active and within the range are copied to the head of the log so that at least a portion of the address space within the range to be cleaned can be reclaimed" [Zwilling col. 5, lines 29-52 with Zwilling, Fig. 2].

It would have been obvious to one of ordinary skill in the art at the time of invention to combine the different embodiments of Zwilling because the invention is directed towards shrinking files.

Zwilling discloses an on-line dynamic file shrink facility comprising shrinking log files, however Zwilling does not expressly disclose in that same embodiment how it the shrinking is accomplished (for instance what type of file a log file is considered as being in Zwilling)..

It would have been obvious to one of ordinary skill in the art at the time of invention to take the copying of blocks and file shrinking process from Zwilling and install it into the shrinking log files of Zwilling, thereby offering the obvious advantage of shrinking log files to save space.

Even though Zwilling is only one reference being used to reject Claim 15, the rejection on Claim 15 is under 35 U.S.C. 103(a) because different embodiments of

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Zwilling are use in the rejection for Claim 15 and its respective dependant claims.

Zwilling teaches all of Claim 15 through Zwilling's different embodiments.

Claim 16 can be mapped to Zwilling as follows: "The method of claim 15, wherein performing the following until each block of data that is active in the range to be cleaned at the tail of the log of data is copied to a head of the log includes updating addresses of that copied blocks of data within a location table" [Zwilling, col. 8, lines 21-46 with Zwilling, col. 9, lines 5-7].

Claim 17 can be mapped to Zwilling as follows: "The method of claim 15, wherein performing the following until each block of data that is active in the range to be cleaned at the tail of the log of data is copied to the head of the log includes updating a minimum address value among addresses of descendent nodes for an entry for the current node in a location table where the minimum address value changes based on copying of the blocks of data associated with the descendent nodes of the current node" [Zwilling, cols. 8-9, lines 21-15 with Zwilling col. 8, lines 20-35 with Zwilling, col. 7, lines 38-21].

Claims 40-43, 45, and 46 encompass substantially the same scope of the invention or are rejected for the same rationale as that of Claims 8-11, 13, and 14, respectfully, in addition to a machine-readable medium and some instructions for performing the method steps of Claims 8-11, 13, and 14, respectfully. Therefore, Claims 40-43, 45 and 46 are rejected for the same reasons as stated above with respect to Claims 8-11, 13, and 14, respectfully.

Claims 47-49 encompass substantially the same scope of the invention as that of Claims 15-17, respectfully, in addition to a machine-readable medium and some instructions for performing the method steps of Claims 15-17, respectfully. Therefore, Claims 47-49 are rejected for the same reasons as stated above with respect to Claims 15-17, respectfully.

Conclusion

30. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brent S. Stace whose telephone number is 571-272-8372 and fax number is 571-273-8372. The examiner can normally be reached on M-F 9am-5:30pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Apu M. Mofiz can be reached on 571-272-4080. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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